Chapter Content

Tables

Figures

Chapter 7
pH, Alkalinity, Hardness, and Turbidity

This chapter summarizes data for pH, alkalinity, hardness, and turbidity collected during the reporting period. A brief overview of the general ranges of these water quality parameters is provided.

pH

The overall pH range for all stations was from 6.3 to 8.9 (Table 7-1). Source waters in the Delta were generally slightly alkaline with median pH ranging from 7.1 to 7.9 (Table 7-1). The pH is generally lower in waters of the American and upper Sacramento rivers than in waters from the San Joaquin River (SJR) and from stations inside the Sacramento-San Joaquin Delta (the Mallard Island, Delta channels, and diversion stations) (Table 7-1). The higher pH at stations of the SJR and inner Delta may be attributable to seawater influences and algal photosynthesis in the nutrient rich waters. Seawater influence slightly increases pH of the water directly, and phytoplankton activity indirectly increases water pH by consumption of dissolved carbon dioxide in the water. The slightly acidic waters were mostly agricultural drainage return waters or waters heavily influenced by agricultural drainage. The lower pH in agricultural drainage waters was probably attributable to the presence of acidic leachates from organic soils.

Table 7-1 Summary of pH at 14 MWQI monitoring stations

Alkalinity

Alkalinity is unregulated. Waters of high alkalinity have an unpleasant taste. According to the federal Disinfectants and Disinfection Byproducts (D/DBP) Rule (EPA 1998), alkalinity is one of the criteria used for removal of total organic carbon (TOC) by enhanced coagulation and enhanced softening. Adequate alkalinity is needed to aid coagulation and flocculation (Breuer 2002 pers comm).

The overall alkalinity at all 14 stations ranged from 16 to 169 mg/L as $CaCO_3$ (Table 7-2). Waters from both the American and upper Sacramento rivers had the lowest alkalinity, whereas waters from the SJR and agricultural drainage stations had the highest alkalinity (Table 7-2).

Table 7-2 Summary of alkalinity at 14 MWQI monitoring stations

Although alkalinity varied at each station, the variations were relatively small for most stations as indicated by the narrow interquartile range (IQR) and by the small differences between the median and average for each station (Table 7-2). When the medians are used for comparing alkalinity among the stations, the American River waters had the lowest median alkalinity of 23 mg/L as $CaCO_3$. The medians for the Delta channel stations, the Sacramento River stations including the Mallard Island station, and the Banks Pumping Plant were from 60 to 67 mg/L as $CaCO_3$. The other stations had a median alkalinity from 73 to 90 mg/L as $CaCO_3$ (Table 7-2). For the 3 diversion stations, median alkalinity ranged from 66 to 73 mg/L as $CaCO_3$ (Table 7-2).

TOC in the Delta rivers, channels, and diversion stations varied widely, but generally fell between 2.0 and 8.0 mg/L (refer to Chapter 4). With the ranges of alkalinity and TOC, the D/DBP Rule would require removal of approximately 25% to 35% of TOC before disinfectants may be added (EPA 1998).

Hardness

Table 7-3 Summary of hardness at 14 MWQI monitoring stations

When all 14 stations are considered, the overall range of water hardness was from 14 to 1,858 mg/L as $CaCO_3$ (Table 7-3). The lowest hardness was found in the American River water, and the greatest hardness was found at Mallard Island, which is heavily influenced by seawater. If the Mallard Island station is excluded, hardness for the river and Delta channel stations ranged from 14 to 245 mg/L as $CaCO_3$; the average and median hardness were from 21 to 123 mg/L as $CaCO_3$ and from 21 to 129 mg/L as $CaCO_3$, respectively. For the 3 diversion stations, hardness ranged from 50 to 270 mg/L as $CaCO_3$, with the average hardness ranging from 86 to 111 mg/L as $CaCO_3$ and the median from 83 to 94 mg/L as $CaCO_3$ (Table 7-3).

Hardness at the 2 SJR stations and the 2 agricultural drainage stations were similar and were approximately twice as high as hardness at the 2 upper Sacramento River stations (Table 7-3). The 2 Delta channel stations, the Banks Pumping Plant, the DMC, and the NEMDC had similar water hardness. However, hardness at the Contra Costa Pumping Plant was somewhat higher than at the Delta channel stations. This may be due to the Contra Costa Pumping Plant's proximity to Mallard Island and the impact from seawater. Electrical conductivity (EC) and total dissolved solids (TDS) were higher at the Contra Costa Pumping Plant than at the Delta channel stations (refer to Chapter 6).

Turbidity

Table 7-4 Summary of turbidity data for 14 MWQI monitoring stations

The turbidity range for all stations was from 1 to 109 NTU (Table 7-4). Of all stations, only the American River at E.A. Fairbairn WTP had an average and median turbidity of less than the maximum contaminant level of 5 NTU; the median and average turbidity at other stations were mostly 10 NTU or more (Table 7-4).

Stations with the highest turbidity include the Mallard Island station, the 2 agricultural drainage stations, and the NEMDC. Average turbidity for these stations ranged from 27 to 40 NTU (Table 7-4). Among the river and channel stations, turbidity values at the SJR stations were higher than those at the Sacramento and Old River stations (Table 7-4). Average and median turbidity at the 3 diversion stations were from 10 to 16 NTU and from 9 to 15 NTU, respectively (Table 7-4).

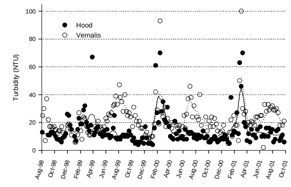

Figure 7-1 Weekly turbidity at Hood and Vernalis stations

Higher turbidity values in these waters are usually associated with heavy runoff during rain events in the watershed. Therefore, turbidity is often higher during wet months than during the dry months as demonstrated by weekly turbidity data from the Sacramento River at Hood and the SJR near Vernalis (Figure 7-1). Water quality at these 2 stations is representative of the waters entering the Delta from the 2 major rivers that supply water to Delta channels. Turbidity at both stations was highly variable during each water year. For the Hood station, turbidity was much higher during the wet months than during the dry months (Figure 7-1). This increase in turbidity resulted from watershed runoff with high turbidity. During the dry months when there was a lack of rainfall, turbidity variations at the Hood station were small (Figure 7-1). At Vernalis, in addition to expected increased turbidity during the wet months, turbidity was highest during the dry months (Figure 7-1). This was mainly attributable to turbid irrigation return waters.

Although both major contributing rivers had their distinct seasonality, such seasonality seems to disappear at the diversion stations (Figure 7-2). Turbidity was lower during part of the wet months and increased from June to October (Figure 7-2). The decreases in turbidity during the wet months may be due to particulate settling when flows are reduced because most dams, reservoirs, and lakes release less water. Also during the wet months low water temperatures reduce phytoplankton activity in Delta channels. Thus high turbidity observed in waters of both the SJR and Sacramento River during the wet months may not be observed in Delta channels and diversion stations. During summer, rapid growth of phytoplankton often causes high turbidity in channel water. In response to high phytoplankton activity during the summer, turbidity was higher during the dry months of each water year (Figure 7-2). In addition, the diversity of water inflows to the diversion stations causes seasonal patterns of turbidity to differ from those of either the Sacramento River or the SJR. Water at the diversion stations include waters from the 2 major rivers, the Sacramento River and the SJR, as well as water from agricultural drainage returns and seawater.

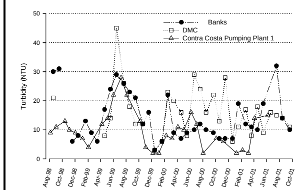

Figure 7-2 Monthly turbidity at three diversion stations

Table 7-1 Summary of pH at 14 MWQI monitoring stations

Station	Sample number	Range	Majority data range	Data dispersion (IQR)	Median
		pH units			
American and Sacramento River stations					
American River at E.A. Fairbairn WTP	37	6.4–7.8	6.6–7.7	7.5–7.6	7.5
West Sacramento WTP Intake	37	6.4–7.8	6.6–7.7	7.5–7.6	7.5
Sacramento River at Hood	160	6.8–7.9	7.1–7.8	7.5–7.7	7.6
Sacramento River at Mallard Island	35	6.9–8.0	7.1–7.9	7.5–7.8	7.7
San Joaquin River stations					
San Joaquin River near Vernalis	160	6.9–8.7	7.2–8.5	7.5–7.9	7.8
San Joaquin River at Highway 4	37	7.1–8.7	7.3–8.4	7.5–8.0	7.7
Delta channel stations					
Old River at Station 9	38	7.1–8.3	7.3–7.9	7.4–7.8	7.7
Old River at Bacon Island	38	7.1–8.9	7.3–8.3	7.4–7.9	7.8
Diversion stations					
Banks Pumping Plant	38	6.6–8.0	6.9–7.8	7.1–7.4	7.2
Delta-Mendota Canal	31	6.9–8.1	6.9–8.0	7.3–7.8	7.6
Contra Costa Pumping Plant	30	7.0–8.7	7.3–8.5	7.7–8.2	7.9
Agricultural drainage stations					
Bacon Island Pumping Plant	25	6.3–8.4	6.5–7.6	6.9–7.3	7.1
Twitchell Island Pumping Plant	35	6.6–7.4	6.7–7.3	7.0–7.2	7.1
Urban drainage station					
Natomas East Main Drainage Canal	41	7.0–8.2	7.1–7.9	7.4–7.7	7.6

Table 7-2 Summary of alkalinity at 14 MWQI monitoring stations

Station	Sample number	Range	Majority data range	Data dispersion (IQR)	Average	Median
		mg/L as $CaCO_3$				
American and Sacramento River stations						
American River at E.A. Fairbairn WTP	37	16–28	18–28	20–25	23	23
West Sacramento WTP Intake	38	47–92	53–87	60–73	67	64
Sacramento River at Hood	159	39–87	47–80	54–69	62	60
Sacramento River at Mallard Island	35	51–86	52–86	58–77	67	66
San Joaquin River stations						
San Joaquin River near Vernalis	159	37–142	45–119	60–117	85	90
San Joaquin River at Highway 4	37	45–122	47–120	69–106	86	88
Delta channel stations						
Old River at Station 9	38	44–85	52–80	58–73	66	67
Old River at Bacon Island	38	43–102	52–78	56–70	64	65
Division stations						
Banks Pumping Plant	38	47–84	50–82	61–72	66	66
Delta-Mendota Canal	31	46–112	54–94	63–81	73	73
Contra Costa Pumping Plant	30	46–153	51–139	62–90	80	73
Agricultural drainage stations						
Bacon Island Pumping Plant	25	32–116	44–116	60–104	79	75
Twitchell Island Pumping Plant	35	64–100	74–98	80–90	85	84
Urban drainage station						
Natomas East Main Drainage Canal	41	34–169	50–138	64–113	88	75

Table 7-3 Summary of hardness at 14 MWQI monitoring stations

Station	Sample number	Range	Majority data range	Data dispersion (IQR)	Average	Median
		----------mg/L as CaCO3----------				
American and Sacramento River stations						
American River at E.A. Fairbairn WTP	37	14–30	14–27	18–23	21	21
West Sacramento WTP Intake	38	42–90	47–78	52–67	60	59
Sacramento River at Hood	160	35–81	42–71	49–61	55	55
Sacramento River at Mallard Island	34	52–1,858	54–1,319	73–519	423	221
San Joaquin River Stations						
San Joaquin River near Vernalis	159	48–245	60–184	85–155	123	129
San Joaquin River at Highway 4	36	55–193	57–181	99–150	122	127
Delta channel stations						
Old River at Station 9	38	51–131	58–124	71–102	86	87
Old River at Bacon Island	38	46–138	52–122	62–93	79	74
Diversion stations						
Banks Pumping Plant	37	61–127	63–114	68–100	86	83
Delta-Mendota Canal	31	60–184	63–153	79–109	98	91
Contra Costa Pumping Plant	30	50–270	54–238	66–147	111	94
Agricultural drainage stations						
Bacon Island Pumping Plant	25	64–403	66–262	89–172	136	118
Twitchell Island Pumping Plant	35	72–261	79–258	89–133	126	113
Urban drainage station						
Natomas East Main Drainage Canal	41	36–165	57–145	80–120	97	86

Table 7-4 Summary of turbidity at 14 MWQI monitoring stations

Station	Sample number	Range	Majority data range	Data dispersion (IQR)	Average	Median
		NTU				
American and Sacramento River stations						
American River at E.A. Fairbairn WTP	37	1–11	1–8	1–2	3	2
West Sacramento WTP Intake	38	6–65	7–28	10–17	15	13
Sacramento River at Hood	160	4–70	5–32	8–15	14	11
Sacramento River at Mallard Island	35	14–66	18–59	21–45	32	27
San Joaquin River stations						
San Joaquin River near Vernalis	160	2–100	8–39	14–26	22	19
San Joaquin River at Highway 4	34	7–37	9–31	14–26	20	21
Delta channel stations						
Old River at Station 9	37	5–20	5–18	8–15	12	12
Old River at Bacon Island	38	4–27	4–24	7–14	12	10
Diversion stations						
Banks Pumping Plant	38	3–68	6–31	9–20	16	12
Delta-Mendota Canal	30	3–45	6–29	11–21	16	15
Contra Costa Pumping Plant	30	2–28	2–22	5–13	10	9
Agricultural drainage stations						
Bacon Island Pumping Plant	24	2–86	11–76	22–54	40	34
Twitchell Island Pumping Plant	35	1–60	12–47	17–34	27	25
Urban drainage station						
Natomas East Main Drainage Canal	41	7–109	10–89	16–32	29	21

Note: All statistics are calculated from positively detected samples only; positive detects are samples with turbidity greater than the reporting limit of 1 NTU.

Figure 7-1 Weekly turbidity at Hood and Vernalis stations

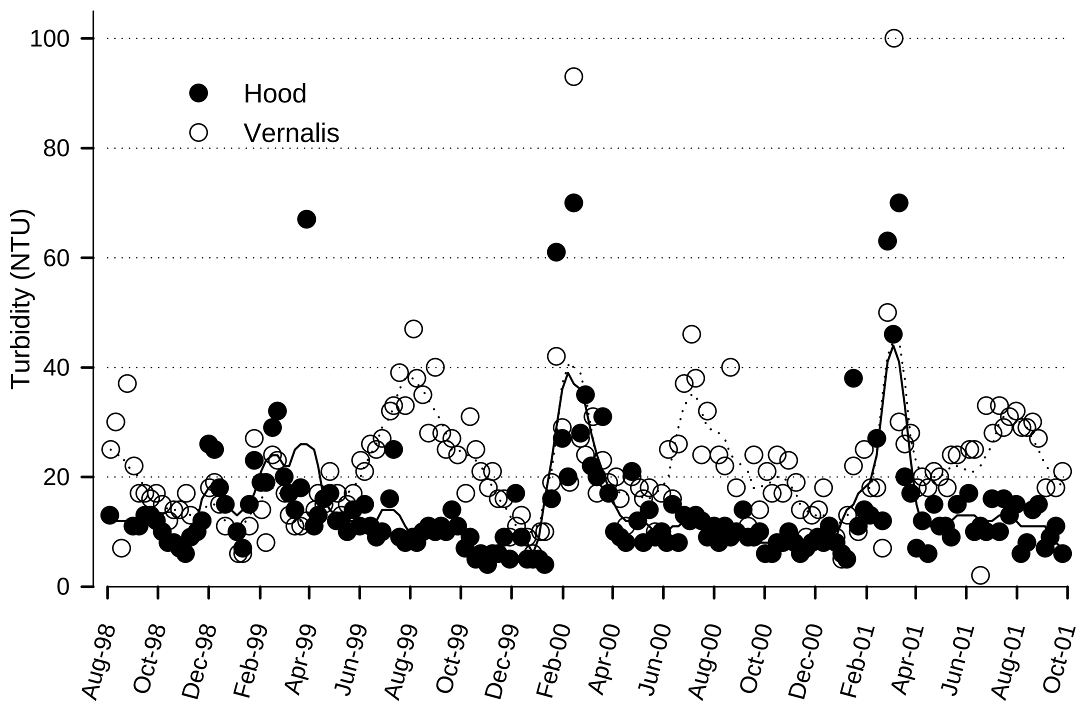

Figure 7-2 Monthly turbidity at three diversion stations